Claims:

1. An ion cyclotron resonance mass spectrometer comprising:

a superconducting magnet for generating an ion confinement magnetic field, the superconducting magnet having a bore;

a vacuum chamber having an ion cyclotron resonance region, said vacuum chamber being received inside the bore of the superconducting magnet; and

a cooling container enclosing both the superconducting magnet and the vacuum chamber and having means for cooling the superconducting magnet and the vacuum chamber together such that the superconducting magnet reaches an operating temperature and the vacuum chamber reaches a temperature similar to the operating temperature of the superconducting magnet and sufficient for providing cryopumping.

2. An ion cyclotron resonance mass spectrometer as in claim 1, wherein the operating temperature of the superconducting magnet is below 120 Kelvin.

3. An ion cyclotron resonance mass spectrometer as in claim 1, wherein the vacuum chamber is cooled to a temperature lower than 80 Kelvin.

4. An ion cyclotron resonance mass spectrometer as in claim 1, wherein the means for cooling uses a liquid cryogen.

5. An ion cyclotron resonance mass spectrometer as in claim 4, wherein the liquid cryogen is liquid helium.

6. An ion cyclotron resonance mass spectrometer as in claim 1, wherein the means for cooling comprising of a cryogen-free refrigerator.

7. An ion cyclotron resonance mass spectrometer as in claim 1, further comprising a radiation shield disposed between the vacuum chamber and the superconducting magnet bore.

8. An ion cyclotron resonance mass spectrometer as in claim 1, further comprising a signal amplifier inside the vacuum chamber and in direct thermal contact with the vacuum chamber.

9. An ion cyclotron resonance mass spectrometer as in claim 1, wherein the superconducting magnet and vacuum chamber are positioned such that the bore of the magnet is in a vertical position.

10. A method of performing ion cyclotron resonance mass spectrometry measurements, comprising:

providing a superconducting magnet for generating an ion confinement field, a vacuum chamber having an ion cyclotron resonance region, said vacuum chamber being received within a bore of the superconducting magnet, and a cooling chamber enclosing both the superconducting magnet and the vacuum chamber to allow the superconducting magnet and the vacuum chamber to be cooled together;

cooling the superconducting magnet and the vacuum chamber until the superconducting magnet reaches an operating temperature and the vacuum chamber reaches a temperature sufficiently cold for providing cryopumping;

energizing the superconducting magnet to generate an ion confinement field in the ion cyclotron resonance region;

injecting ions to be studied into the ion cyclotron resonance region of the vacuum chamber; and

detecting cyclotron resonance signals generated by the ions.

11. A method as in claim 10, wherein the step of cooling cools the superconducting magnet to an operating temperature below 120 Kelvin.

12. A method as in claim 10, wherein the step of cooling cools the vacuum housing to a temperature below 80 Kelvin.

13. A method as in claim 10, wherein the step of cooling is by means of a liquid cryogen.

14. A method as in claim 13, wherein the liquid cryogen is liquid helium.

15. A method as in claim 10, wherein the step of cooling is by means of a cryogen-free refrigerator.

16. A method as in claim 10, wherein the step of detecting is by means of a signal amplifier placed inside the vacuum chamber and in direct thermal contact with the vacuum chamber.

17. An ion cyclotron resonance mass spectrometer comprising:

a magnet for generating an ion confinement magnetic field within a bore of the magnet;

a vacuum chamber having an ion cyclotron resonance region, said vacuum chamber being received inside the bore of the magnet; and

means for cooling the vacuum chamber to a temperature sufficiently cold for a wall of the vacuum chamber to provide cryogenic pumping inside the vacuum chamber.

18. A method of performing ion cyclotron resonance mass spectrometry measurements, comprising:

providing a magnet for generating an ion confinement field and a vacuum chamber having an ion cyclotron resonance region, said vacuum chamber being received within a bore of the magnet;

cooling the vacuum chamber to a temperature sufficiently cold for a wall of the vacuum chamber to provide cryogenic pumping inside the vacuum chamber;

energizing the magnet to generate an ion confinement field in the ion cyclotron resonance region;

injecting ions to be studied into the ion cyclotron resonance region of the vacuum chamber; and

detecting cyclotron resonance signals generated by the ions.